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## PROCESS FOR GELLING LIQUID NITROPARAFFINS

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3 Claims. (Cl. 52—13)

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This invention relates to nitroparaffin-con-  
taining substances, and has for its principal ob-  
ject to provide a gel containing nitroparaffin,  
and a process of forming it.

This is a division of my copending application  
Serial No. 725,977, filed February 1, 1947.

Liquid nitroparaffins have heretofore been em-  
ployed as propellants in jet propulsion devices,  
and they have also been used in explosives. It is  
desirable for some types of operating conditions  
to employ the liquid nitroparaffins in a solid or  
semi-solid form, or gel, for these purposes. Up  
to the present time, difficulty has been encoun-  
tered when it was attempted to produce gels from  
the various liquid nitroparaffins without seriously  
affecting their oxygen balance and otherwise  
changing their properties.

By the present invention I have discovered a  
method for thickening, gelling, or solidifying liq-  
uid nitroparaffins and forming semi-solid or solid  
gels which retain their consistency for a period  
of time without undergoing any marked change.

This invention is, in general, directed to solidi-  
fying or gelling any of the liquid nitroparaffins  
including the mono, and poly nitromethanes,  
mononitroethane, mononitropropane, mononi-  
troisopropane, mononitrobutanes, mononitroiso-  
butanes, mononitropentanes and the like which  
are normally liquid compounds at room tempera-  
tures. Thus, I may employ any of the liquid  
nitroparaffins, such as mononitromethane (com-  
monly called nitromethane, and so designated  
hereinafter), dinitromethane, nitroethane, nitro-  
propane, nitrobutane, and the like or any mix-  
tures of the liquid nitroparaffins or solutions of  
any of the normally solid polynitroparaffins hav-  
ing sufficient oxygen to sustain self-combustion  
in nitromethane. Nitromethane is usually the  
preferred nitroparaffin for propellant and explo-  
sive purposes, in that it forms a very satisfactory  
self-combustible propellant when gelled with  
nitrocellulose and employed in the manner in  
which such propellants are usually used; and a  
very satisfactory explosive when gelled in combi-  
nation with a sensitizer or otherwise treated and  
handled in the manner of an explosive.

I have discovered that it is possible to produce  
a homogeneous semi-solid or solid gel from liquid  
nitroparaffins by dissolving or adding to the liq-  
uid nitroparaffins, such as nitromethane, nitro-  
ethane and the like, a quantity of nitrocellulose.  
Various commercial forms in which nitrocellu-  
lose suitable for the purpose, may be obtained  
are: Pyrocellulose, pyroxylin, guncotton, etc., all  
of which are trade names for such nitrocellu-  
loses.

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The gelling of the nitroparaffins is preferably  
conducted at room temperatures, or tempera-  
tures not more than slightly above room tem-  
peratures, since both nitroparaffin and nitrocel-  
lulose become explosive when confined and sub-  
jected to more elevated pressures and tempera-  
tures. This is particularly true when a sensitiz-  
ing agent has been added to nitromethane to  
assure its action as an explosive. At elevated  
temperatures, that is, above 350° F., nitrometh-  
ane, for example, becomes extremely sensitive  
to shocks and at still higher temperatures may  
explode without subjecting the liquid to any  
shock whatsoever.

The gels produced from nitrocellulose and a  
liquid nitroparaffin may be compounded, by ad-  
justing the proportions to give gels having vary-  
ing degrees of viscosity. These range from  
syrupy materials to solid gels. For practical pur-  
poses the gels employed vary from between about  
5% to 75% nitrocellulose by weight based on the  
weight of nitroparaffin used. Gels may be made  
to contain any amount above 75% nitrocellulose  
by weight based on the weight of the total mix-  
ture, but even 75% nitrocellulose gels are prac-  
tically solid, therefore, there is little advantage  
from this standpoint in using a higher percent-  
age of nitrocellulose.

Since nitroparaffins of the type of nitrometh-  
ane, and nitrocellulose both have sufficient oxy-  
gen in their molecules to insure their complete  
combustion, these substances are capable of  
burning to completion at ambient conditions  
without requiring the addition of oxidizers.  
Gelled nitroparaffins such as nitromethane are  
particularly useful where it is desired to employ  
these substances as solid or semi-solid explosives  
or as self-combustible solid propellant fuels such  
as are used in self-contained rocket motors.

The nitroparaffin gels prepared according to  
my invention may be employed either as explo-  
sives or as self-combustible propellants, depend-  
ing upon the manner of use. The gels are ex-  
plosive when detonated with sufficient force but  
may readily be adapted to be burned as fuels,  
particularly in jet propulsion motors, in the ab-  
sence of detonation. If it is desired to prepare  
a nitroparaffin gel to be used as an explosive I  
may incorporate in the liquid nitroparaffin, prior  
to gelling, a sensitizer. Such sensitizers as the  
organic amines disclosed by Laurence in patent  
application Ser. No. 605,747, filed July 18, 1945,  
are highly satisfactory, including the aromatic  
amines such as aniline, diphenylethylenediamine  
and the like and the aliphatic amines such as  
diethylamine, tetraethylene pentamine and the

like. A nitroparaffin gel in which a sensitizer such as one of the organic amines is incorporated is much more sensitive to detonation than is the gel in the absence of the sensitizer, although it is to be understood that the use of a sensitizer is optional; and the gels may be employed as explosives either with or without a sensitizer.

Thus mixtures of nitromethane or other nitroparaffins and nitrocellulose containing from about 75% to about 85% by weight of nitroparaffin based on the total weight may be satisfactorily used as explosives in conjunction with a suitable detonator. Higher proportions of nitrocellulose may be employed; this tends to decrease the explosive strength.

Mixtures of nitroparaffin and nitrocellulose containing from 79% to 83% by weight of nitroparaffin such as nitromethane based on the total weight of the mixture are easily exploded by the shock of a No. 8 fulminate type of blasting cap, yet in the absence of shock, such mixtures (containing as high as 74% to 84% by weight of nitromethane in combination with nitrocellulose) may be confined and burned satisfactorily as restricted propellant charges without exploding. A restricted propellant charge is defined as one in which the burning occurs over a predetermined face of limited area and does not take place simultaneously over the entire outside surface of the propellant mass. Restriction may be accomplished by coating all surfaces except the burning surface with a liner which is adhesive to the propellant mass and has a slower burning rate than the material forming the principal charge. Examples of adhesive liners suitable for confining the burning are ethylcellulose, cellulose acetate, cellulose butyrate, cellulose acetate butyrate, etc.

The burning properties of solid propellant charges compounded by gelling nitromethane with nitrocellulose may be greatly improved by adding suitable catalysts to the nitromethane before gelling. A particularly desirable catalyst for assisting the easy ignition of nitromethane is chrome acetyl acetone. Small amounts of this substance ranging between a trace up to approximately 3% by weight may be used to improve the burning of nitromethane.

The ratio of nitroparaffin to nitrocellulose may, as stated, be varied over a wide range of proportions ranging from a trace of nitrocellulose in liquid nitroparaffin to a trace of nitroparaffin in nitrocellulose. The amount of nitrocellulose which may be incorporated into the liquid nitroparaffin by stirring or agitation alone will not appreciably exceed 45% based on the weight of the nitroparaffin employed.

A fairly substantial gel may be formed by dissolving in nitroparaffin as low as 10% nitrocellulose by weight based on the weight of the nitroparaffin while a reasonably stiff gel is obtained when the amount of nitrocellulose employed is increased to 20% or 30% by weight based on the weight of the nitroparaffin employed. Particularly stiff gels are formed when 40% to 50% by weight of nitrocellulose based on the weight of nitroparaffin present is employed.

If it is desired to incorporate amounts of nitrocellulose in excess of 45% by weight, it is preferable to mill or knead the mixtures of nitrocellulose and a liquid nitroparaffin to insure a more homogeneous mixture.

The process herein described possesses the advantage that any desired consistency of gel may

be easily produced from nitroparaffins. Sensitized nitroparaffin such as nitromethane may, by careful selection of the proportions of nitromethane to nitrocellulose, be used either as a solid or semi-solid explosive. Non-sensitized nitromethane and other self-combustible nitroparaffins may be made into self-combustible solid propellants, or may be used as explosives when detonated with sufficient force.

10 The following examples of gels made according to my invention serve to illustrate the application of the invention.

*Example 1.*—A gel consisting of 80% by weight of nitromethane and 20% by weight of nitrocellulose has been prepared by dissolving the nitrocellulose in the nitromethane at 75° F. The gel thus formed was very stable and fairly rigid. Additional gels consisting of nitromethane and nitrocellulose were made in similar manner and contained nitrocellulose varying in proportions from about 10% to 50%.

*Example 2.*—Numerous other gels have been prepared by dissolving nitrocellulose in nitropropane and nitroethane at temperatures ranging from approximately 70° F. to 90° F. These gels consisted of from about 50% to 90% by weight of the respective nitroparaffin and from about 10% to 50% by weight of nitrocellulose.

*Example 3.*—A gel consisting of 14.6% by weight of nitrocellulose dissolved in 85.4% of nitromethane formed a thick fluid gel.

*Example 4.*—A gel consisting of 25% nitrocellulose and 75% nitromethane was prepared by dissolving the nitrocellulose in the nitromethane at approximately 75° F. This produced a fairly stiff gel.

*Example 5.*—A solution of 50% nitromethane into which has been dissolved 50% of nitrocellulose produced a very stiff gel having substantially solid properties.

*Example 6.*—A sample of a gel consisting of 75.3% nitromethane which had dissolved therein 22.9% nitrocellulose was made more active by the addition of 1.8% of chrome acetyl acetone. This formed a fairly stiff gel having suitable burning properties for a restricted propellant charge.

*Example 7.*—29.8% of nitrocellulose was dissolved in 69.2% of nitromethane and 1.0% of chrome acetyl acetone was added to the mixture. This formed a stiff gel which appears to be very satisfactory when employed as a solid propellant charge.

Other gels which may be satisfactorily formed due to the fact that nitrocellulose is a good gelling agent for nitromethane and similar nitroparaffins are those which are made from solutions of solid organic polynitrocompounds in nitromethane. Examples of these substances are trinitrotoluene, polynitrobenzene, dinitropropane, dinitroethane and other higher polynitroparaffins which possess sufficient oxygen in their molecules to sustain their self-combustion. These are selected to produce propellants having the required properties such as hardness, temperature coefficient and freedom from detonation.

An additional advantage of my process apparent from the foregoing examples, is that the ingredients may be compounded at ambient temperatures and require little or no heating, thus eliminating the hazard present when propellants are subjected to temperatures greatly in excess of ambient. This is particularly desirable in view of the fact that nitro-paraffins, such as

nitro-methane, become more sensitive to shocks at elevated temperatures.

A particularly desirable feature, inherent in restricted burning propellant charges formed from solid gels of the above ingredients, is that the gases produced when these charges are burned in a jet motor are substantially smokeless, non-corrosive and nontoxic. The specific impulse obtained by burning nitro-methane, or any other of the nitroparaffins having sufficient oxygen in the molecule to support their own combustion, in combination with nitrocellulose is not appreciably lower than that developed by the nitroparaffin alone.

Gels compounded from sensitized nitro-methane and nitrocellulose may be formed into sticks similar to dynamite and may be substituted for dynamite since sensitized nitromethane when exploded compares favorably with nitroglycerin in shattering properties and power. The addition of nitrocellulose does not appear to affect the ease with which sensitized nitromethane can be exploded when subjected to shocks.

I claim:

1. A composition of matter comprising from about 10% to 50% by weight of nitrocellulose, 50% to 90% by weight of nitromethane, and a sensitizer from the group consisting of aniline, diphenylethylenediamine, diethylamine and tetraethylene pentamine.

2. A composition of matter consisting of a mixture of a liquid nitroparaffin, nitrocellulose and a sensitizer consisting of organic amine from the group consisting of aniline, diphenylethylenediamine, diethylamine and tetraethylene pentamine, the weight of the nitroparaffin being between 50% and 85% by weight based on the weight of the total mixture, and the weight of the nitrocellulose being between 15% and 50% by weight based on the weight of the total mixture.

3. A composition of matter consisting of a nitromethane, nitrocellulose and a sensitizer comprising an organic amine from the group consisting of aniline, diphenylethylenediamine, diethylamine and tetraethylene pentamine, the weight of the nitromethane being between 50% and 85% by weight based on the weight of the total mixture, and the weight of the nitrocellulose being between 15% and 50% by weight based on the weight of the total mixture.

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